

severity of arterial and venous disease in all areas of the body.

Duplex scanning, a technique that combines the use of real-time B-mode ultrasound imaging with a computerized analysis of frequency data from pulsed-Doppler signals from the pertinent arteries, has emerged as the technique of choice for evaluating the extracranial cerebral vessels. Using this technique, competent operators can detect both the presence and severity of disease in the carotid and vertebral arteries with an accuracy exceeding 90%. In addition to its important clinical role, duplex scanning is an accurate research method, and data obtained using this technique have been the primary source of our recent improved understanding of the incidence and natural history of carotid artery disease, as well as the outcome of therapy. Sufficient information is available to accurately determine risk categories based on patient characteristics and duplex scan results. The screening of asymptomatic patients with risk factors for cerebrovascular disease is now eminently justified.

The rapid expansion of therapeutic methods being applied to peripheral arterial disease—conventional surgical procedures, balloon angioplasty, laser angioplasty, atherectomy with rotating or cutting tips (or both), thrombolytic therapy, and new pharmacologic agents—mandates the objective assessment of indications and results. Impressive evidence has been accumulated that the prognosis for patients with peripheral arterial disease is more closely related to the magnitude of objective changes in distal extremity pressures and waveforms than to any combination of symptoms or angiographic findings. Similarly, the results of treatment of any type can only be accurately assessed by comparing before and after procedure pressures, waveforms, and treadmill walking distance, rather than by symptoms or by the angiographic demonstration of patency. A major advance in the postoperative follow-up of lower extremity bypass grafts has been the finding that a decreased graft flow velocity, as determined by the duplex scanner, is a reliable indicator of a failing graft that occurs before the loss of distal pulses, a decrease in ankle pressure, or the occurrence of symptoms. This finding has permitted the salvage of many grafts that previously would have failed. It is clear that the diagnosis, prognosis, selection of therapy, and evaluation of the results of therapy in peripheral arterial disease all rely heavily on noninvasive testing for optimal results. Again, regular periodic screening of asymptomatic patients at risk, as well as of those treated both operatively and nonoperatively, is indicated.

The noninvasive evaluation of visceral arteries is prompted by a desire to detect renovascular hypertension and chronic mesenteric ischemia. The recent improvement in duplex scanning instruments, including phased-array ultrasound and color-Doppler imaging, has resulted in improved diagnostic capabilities in this area. Reliable criteria exist to permit the accurate diagnosis of renal artery stenosis. An inability to successfully image the renal arteries of all patients remains a problem, although much less so than with previous instruments. The superior mesenteric and celiac arteries can be imaged and flow data obtained.

The noninvasive detection of venous thrombosis has most often been done by using indirect plethysmography combined with the use of the hand-held Doppler. The improvements in duplex scanners cited earlier have resulted in this direct method being applied to venous diagnosis as well, with

greater accuracy. In particular, the use of color Doppler permits the accurate detection of nonocclusive venous thrombosis and the reliable diagnosis of calf vein thrombosis in many patients. The current accuracy of venous thrombosis testing using duplex scanning exceeds 90% and establishes this as the diagnostic procedure of choice.

Testing for chronic venous disease using the duplex scanner, as well as photoplethysmography, permits a reliable detection of valvular incompetence, chronic venous obstruction, and elevated venous pressures. This testing is ideally suited to evaluate indications for, and results of, any venous reconstructive procedure.

The use of the duplex scanner to evaluate renal transplants has resulted in reliable criteria for the noninvasive diagnosis of acute allograft rejection, as well as of arterial and venous thrombosis or stenosis.

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## Preventing Postoperative Thromboembolism

THE INTRODUCTION of the low-dose-heparin concept more than a decade ago seemed to offer the promise of a simple, safe, and effective means of preventing postoperative thrombophlebitis and, more important, of decreasing the risk of related pulmonary embolism. The administration of 5,000 units of heparin subcutaneously two or three times a day was straightforward, and an international cooperative study of thromboembolism prophylaxis following hip operations seemed to verify its effectiveness.

Nonetheless, there has been considerable disillusionment with the concept. We found no apparent benefit in a randomized group of trauma patients. When bleeding complications occurred, they were always considered to be caused by the drug, even though there was no difference in the incidence of bleeding complications in the two groups.

The rationale for using low-dose heparin is that heparin functions primarily as an antithrombin III cofactor, greatly augmenting its antithrombotic effect. The fallacy of this concept is that if a patient has a condition such as disseminated cancer, severe trauma, shock, or major tissue injury, the clotting tendency generated by these states depletes antithrombin III so that heparin is not functional. This difficulty of predicting whether a given dose of heparin will be effective has diminished enthusiasm for its use.

Factors that seem to decrease the risk of postoperative thromboembolism are early ambulation, elastic compression, leg elevation, the administration of dextran, and the use of intermittent pneumatic compression. Of these, early ambulation has clearly established itself as relieving stases and has become a fundamental aspect of surgical care. Maintaining good hydration, thus ensuring good extremity perfusion, is also a basic aspect of care, but its importance has not been as well recognized.

When a patient is bedridden, elevating the limb is beneficial but uncomfortable and difficult to maintain, particularly in elderly patients. Elastic stockings or elastic compression when tight enough to be effective may not be tolerated by a patient.

In severely ill patients, the greater clotting tendency requires more potent therapy. Low-molecular-weight dextran, a viscosity-lowering solution, provides effective prophylaxis. On the day of an operation, 1 to 2 units are administered, followed by 1 unit given daily for the first three to four postoperative days.

Intermittent pneumatic compression has proved to effectively prevent clot formation. The original rationale was that it squeezed blood out of the leg and prevented stasis. It now seems that calf muscle compression works by activating fibrinolysis; hence, the effect may be not only local but systemic. The disadvantages are its cost and patient discomfort.

Finally, there is a group of patients at high risk who have a history of clotting complications. Many of these patients, when studied with sophisticated tests, will be found to have some abnormality of blood antithrombotic or fibrinolytic factors. This group is best treated by carrying out an operation using heparin or sodium warfarin anticoagulation and the bleeding risks accepted. Heparin can be administered by continuous intravenous infusion in amounts sufficient to raise the partial thromboplastin time slightly. With the use of warfarin, the infusion is started several days before the operation and the prothrombin time maintained at 15 to 20 seconds.

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## Restoration of Renal Function by Renal Revascularization

RENAL REVASCULARIZATION is most commonly done to ameliorate renin-mediated renovascular hypertension. Recently, however, a growing body of clinical evidence indicates that such a procedure restores significant excretory function as well, even in kidneys that have minimal to nonexistent preoperative function.

The salutary effects of revascularization on renal function were reported in 1960 in eight patients in whom pronounced renal failure was reversed. More recent publications in 1980 and 1985 have documented clinical, biochemical and radiographic improvements in renal function in 47 kidneys that were nonfunctional before revascularization.

The clinical recognition of poorly functioning kidneys most commonly occurs in the course of an evaluation for renovascular hypertension. Laboratory evidence—blood urea nitrogen and creatinine values—of renal excretory dysfunction is absent. Unilateral renal artery occlusion with nonvisualization of kidney parenchyma is seen arteriographically. A less common clinical presentation but one that is important to recognize is a case of hypertension with underlying atherosclerotic vascular disease and laboratory

evidence of renal failure. The onset of renal failure is characteristically rapid, and dialysis may be necessary. An arteriogram shows severe bilateral renal artery disease with minimal to no function. This subset of patients benefits most from revascularization because it restores sufficient renal function to eliminate the need for dialysis.

The recognition that revascularization can restore valuable renal function and ameliorate systemic hypertension has changed the surgical approach to patients with nonfunctioning kidneys. Whereas primary nephrectomy was used liberally in the past, it is rarely indicated today. The operative strategy is directed towards revascularizing all kidneys. Such a strategy is possible when the distal and segmental branches of the renal artery are patent and the renal parenchymal length is 5 cm or more. In the few patients where this is not the case, primary nephrectomy is advisable. Revascularization is usually accomplished by an aortorenal bypass. The gastroduodenal artery on the right and the splenic artery on the left may also be employed to revascularize the kidney. Using these celiac branches has the advantage of eliminating the need to cross clamp the aorta, and the operation can be accomplished nicely through a subcostal incision.

The long-term follow-up of patients undergoing revascularization shows considerable late mortality within two years. Death is not related to renal failure since improved renal function is maintained. Rather, coronary artery disease and myocardial infarction are the causative factors. Attention to cardiac risk factors and symptoms is thus important in maximizing the therapeutic benefit of revascularization.

The benefits of renal revascularization on renal function can be substantial, but certain questions remain to be answered, such as what the role of revascularization is in a patient who does not have hypertension but has severe renal artery disease. Many authors think correction of these "asymptomatic" stenoses improves and preserves renal function, but data are lacking to confirm this contention. Can clinical, biochemical, or radiographic preoperative predictors of the successful retrieval of renal function be defined? Several criteria have been proposed to be predictive, but none are absolute. Answers to these and other questions are needed to optimize the therapeutic effects of renal revascularization on renal excretory function.

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## Hernioplasty Procedures for Inguinal Hernia

THE TREATMENT OF HERNIAS continues to be an important topic in the surgical literature primarily because the recurrence rate following hernia repair remains unacceptably high. The excellent results reported by many authors are unfortunately due to short or incomplete follow-ups and not the skill of a surgeon or the particular technique used for the repair. Patients with recurrent hernias frequently attribute the problem to their surgeon and consequently do not return to that surgeon for repair of the recurrence. This factor gives